

PROJECTS

ACROPORA SPP. STATUS OVERVIEW (Miller and Williams)



Acropora palmata (Elkhorn coral) is one of the dominant framework builders on Caribbean reefs. Its branching morphology and tendency to form dense mono-specific stands naturally provides shelter to a variety of fish and other ecologically and economically important reef organisms, including *Diadema antillarum* (Long-spined sea urchin) and *Panulirus argus* (Caribbean spiny lobster). Since the 1970s, acroporid species in the Caribbean have experienced extreme and accelerating declines estimated at 90 to 98 % throughout their range. Much of the decline has been attributed to widespread white-band disease but the overall loss is thought to have been exacerbated by more frequent and intense bleaching events, hurricanes as well as other diseases and anthropogenic effects. Loss of this structurally complex framework builder has diminished zonation and thus species diversity on Caribbean reefs. The severe and protracted population decline led NOAA Fisheries to designate the listing of this species (along with its congener, *Acropora cervicornis*) as 'threatened' under the U.S. Endangered Species Act in May 2006.

RELEVANT LINKS

NOAA Coral Reef Conservation Program

<http://www.coralreef.noaa.gov>

Florida Keys National Marine Sanctuary

<http://floridakeys.noaa.gov>

Dr. Caroline Rogers, USGS

<http://soundwaves.usgs.gov/2003/07/awards.html>

ACROPORA SPP. STATUS

Assessment of threats to *Acropora palmata* in the Florida Keys: Proximal causes and their relative importance to remnant populations. (Williams, Miller, Kramer)

Principal Investigator: Dana E. Williams, Ph.D.

Co-Principal Investigator: Margaret W. Miller, Ph.D.

Project Summary:

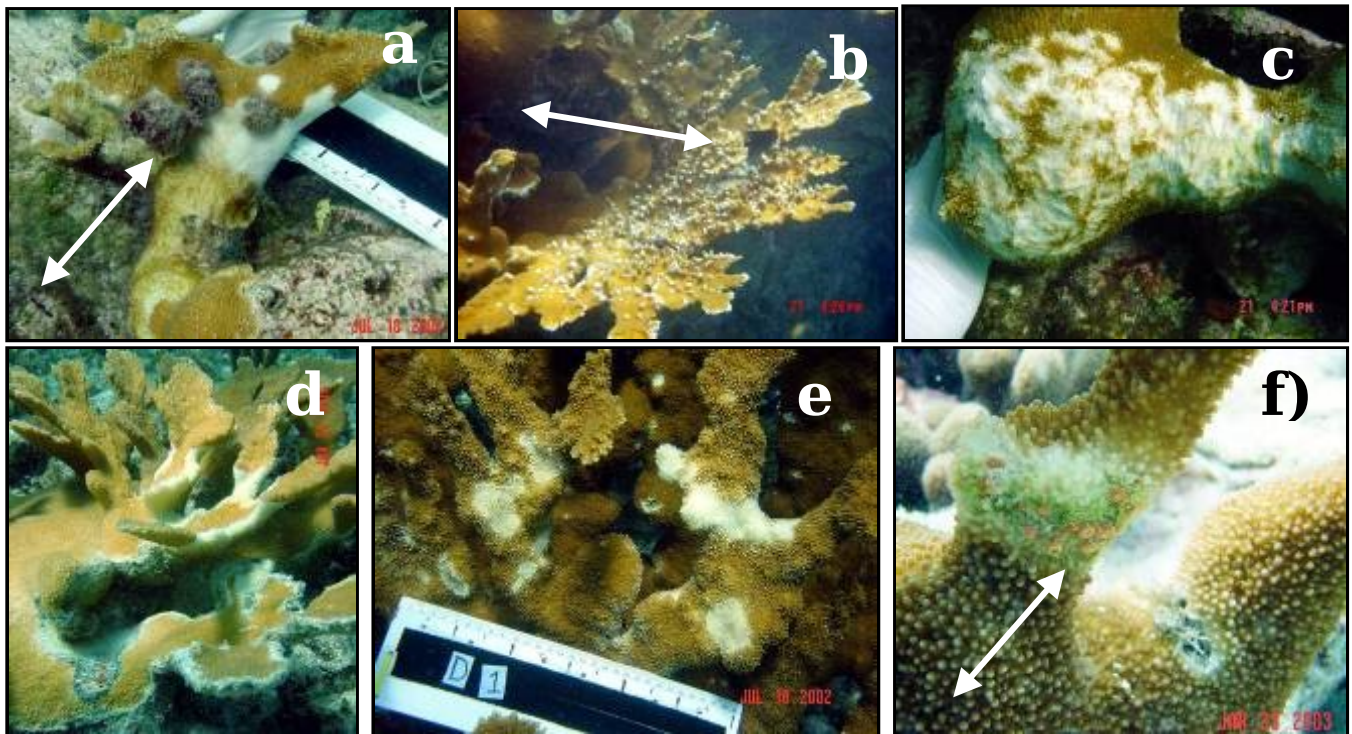
The overall objective of this project is to determine the relative importance of each potential 'threat' (disease, predation etc) among the remaining elkhorn populations in the upper Florida Keys. Fifteen study plots were established at 5 reefs in the upper Florida Keys National Marine Sanctuary. All elkhorn colonies in the study plot were carefully mapped and approximately 12 colonies within each plot were selected randomly and tagged (n=200). Every three months the tagged colonies are photographed and assessed for the presence of any threats and the entire study plot is searched for new 'recruits' to the population.

This study will yield information on the current status and distribution of the candidate species *Acropora palmata*; characterization of threats to this coral including predation, disease and overgrowth as well as relative importance of each threat to the persistence or recovery of this species in the Florida Keys.

Preliminary results: The first year of this study (spring 2004 thru spring 2005) has documented an average $11\% \pm 6\%$ (mean \pm SD) decline in the 'Live Area Index' (LAI; colony dimension adjusted for the percent cover of live tissue) of tagged colonies at 10 of the 15 plots, while 2 remained unchanged and 3 increased on average $17\% \pm 10\%$ (mean \pm SD). Surveys of the study plots 3 days after Hurricane Dennis passed (7/9/2005) revealed the somewhat expected severe fragmentation but additionally revealed severe tissue loss that progressed for the following weeks until our most recent quarterly survey. Decreases in the LAI following Hurricane Dennis exceeded the losses accumulated over the previous year at all but 2 of the study plots. Much of the live area loss was caused by fragmentation which could be recovered if the fragments survived to reattach (recruit). However, on average $71\% \pm 22\%$ (mean \pm SD) of the hurricane generated fragments in a study plot were dead or dying rapidly by mid August suggesting that recruitment would not succeed. Hurricane Katrina passed by on 8/25/2005, and while it resulted in only minor damage to *A. palmata* colonies within the study sites, it disrupted the surviving fragments from Hurricane Dennis. On 9/20/2005 Hurricane Rita passed south of the Florida Keys. Major structural damage occurred at many of the study sites and entire colonies were disrupted. Presumably the loose structures generated by earlier storms exacerbated the wave-damage, few fragments were found in the study plots following this storm since the remaining loose fragments were removed by the wave action and few branches remained prior to the storm to generate fragments. On 10/24/2005 Hurricane Wilma passed to the north of the Upper Keys resulting in further damage to the remaining colonies with few fragments remaining in the study plots. More detailed analyses of the effects of the 2005 hurricane season are underway.

Prior to Hurricane Dennis, declines were largely explained by a disease consistent with white pox (Rodriguez-Martinez et al. 2001, Patterson et al. 2002, Sutherland et al. 2004). White pox affected colonies were observed with numerous scattered patches of tissue mortality that were frequently observed healing by the next survey. However in some cases these patches would increase in size leaving large portions of a colony dead by the next survey. Disease prevalence (Fig. 3) severity varied greatly between study plots; even among those on the same reef (e.g. plots at Molasses are less than 300m apart but have dramatically different disease trends). Prevalence of other 'threats' such as *Coralliophila abbreviata* (snail) predation or *Stegastes planifrons* (three-spot damselfish) also varied greatly between sites but has thus far resulted in far less tissue loss than has disease.





Various colony conditions ('threats') commonly found affecting elkhorn coral in the Florida Keys: **a)** *Coralliophila abbreviata* (snail) predation, note actively feeding snails (at arrow) and algae colonizing the dead skeleton towards the base; **b)** *Stegastes planifrons* territory (damselfish visible at arrow); **c)** 'focused biting' by parrotfish, likely *Sparisoma viride* based on crenulated scrape marks; **d)** White-band disease; **e.** Patchy necrosis; **f)** Excavating sponge (*Clion sp.*) note orange papillae (at arrow) showing through newly exposed skeleton.

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ACROPORA SPP. STATUS

NMFS Acroporid mapping project (Miller, Williams, Kramer)

Margaret W. Miller and Dana E. Williams- Co-Principal Investigators.

This project is a targeted survey effort aiming to better characterize the distribution of living and historical acroporid populations in the upper Florida Keys. Visual surveys of patch reef, back reef and shallow fore reef areas from Carysfort to Alligator reefs using two or more snorkelers, hand-held GPS units and diver propelled vehicles (DPV) will be used to document the location of live *Acropora palmata* and *A. cervicornis* colonies as well as areas of extensive intact dead thickets. Using available habitat maps, we are initially targeting reef areas <3m deep. Waypoints (colonies) and tracks (representing area searched) recorded during surveys will be used in cooperation with SERO to generate a GIS map of acroporid distribution which can be used for pilot management planning and critical habitat planning. The map will show 5 area designations: 1) living *A. cervicornis* or 2) living *A. palmata* population, 3) historical population 4) absence and 5) not searched. This map will continually evolve until all areas are searched which is expected to take up to 2 years. However, while in progress it will still provide valuable

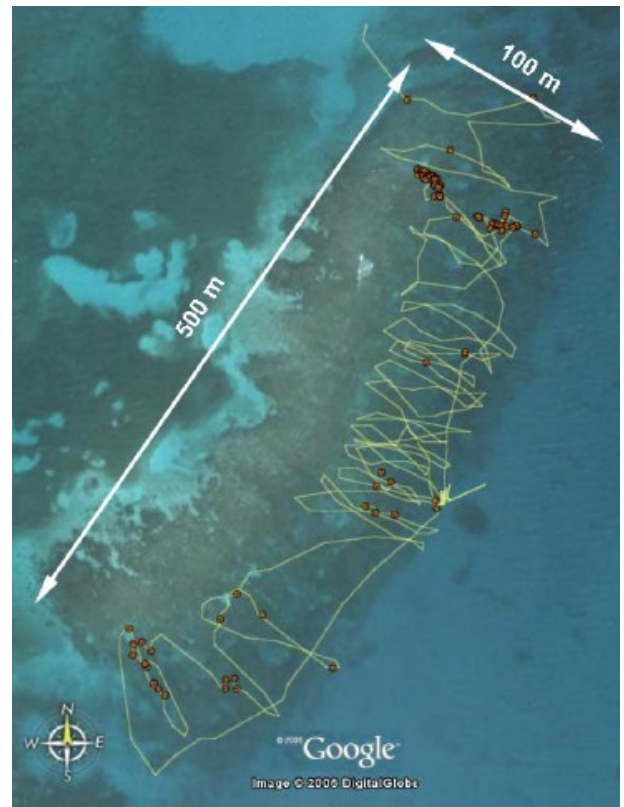
data to other researchers and resource managers.

Figure 1. Example of raw scooter mapping data. The yellowline represents the track surveyed by the mappers and the orange dots represent individual colonies of *A. palmata*. This fore-reef area was surveyed by two mappers in approximately 90 minutes using the protocol described here.

Areas targeted for survey were selected based on the intersection of coral reef and 3m depth or less bathymetry on the Florida Reef Tract Marine habitats and Ecosystems Map Published by University of Miami RSMAS and Florida Dept Natural Resources (ca. 1980). The subset of areas we have surveyed to date (May 2006) were specifically chosen based on practical considerations, including weather conditions, available time, available personnel and proximity to other activities being conducted on the day of the survey. While areas are targeted based on the 3m bathymetry contour, surveys continued outside of this depth when the substrate characteristics were appropriate for *Acropora* spp. habitat (hard bottom with other corals present), and visibility allowed for adequate view of the benthos (usually less than 6m).

Survey method varies depending on the site characteristics. The primary method involves a snorkeler at the surface with a handheld GPS and a scooter surveying linear swaths, marking each *Acropora* spp. colony encountered until an area is covered. The track recorded by the GPS is used to record the approximate coverage of a site. The spacing of the tracks that is needed for complete coverage of a site will vary since the width of the swath that is visible by the snorkeler varies with the site conditions (including depth, relief and water visibility). The intention of the scooter method is to space the linear tracks so that the snorkeler can see full swath yet overlap (repeated marking of a colony) is minimized.

Detailed Protocol



ACROPORA SPP. STATUS

Restoration of storm-generated *Acropora* spp. fragments in Biscayne National Park. (Williams, Miller and Kramer)

Dana E. Williams and Margaret W. Miller, Co-Principal Investigators

The natural life history of acroporid corals relies strongly on fragmentation and the successful recruitment (reattachment) of the fragments (Fong and Lirman 1995). This reproductive strategy can foster rapid proliferation and spatial dominance; however it can also result in losses since the loose fragments are more vulnerable. Once broken, branches may nestle into surrounding reef structures and reattach, or may be transported to sandy areas where they become abraded or smothered and can not attach. Historically, the benefits of this strategy have apparently outweighed the costs (Lirman 2000).

Although, asexual reproduction through fragmentation is a natural process, its success is severely hindered in the presently degraded condition of remnant *A. palmata* typically found in the Florida Keys Reef Tract. Increased bioerosion associated with degraded water quality (Ward-Paige et al. 2005) may result in increased fragmentation due to weakened skeletons. Increased fragmentation could result in faster proliferation, however it would also prevent colonies from reaching the extremely large sizes seen in historical populations.

Previous studies have shown that survival of the fragments is highly dependent on their ability to reattach to suitable substrate (Lirman 2000). There is evidence that successful recruitment of these fragments is declining. Surveys of *A. palmata* patches following hurricanes have revealed that fragments generated by the storm were less likely to be retained in the lower density stands (Fong and Lirman 1995, Miller et al. 2002, pers. obs.) typical of present populations. Also, the remaining colonies in the Florida Keys Reef Tract have typically suffered partial mortality, and thus have reduced area of their skeleton that is covered with live tissue. Since live tissue is required for reattachment to the substrate, a fragment that is not entirely covered with live tissue has a diminished ability to fuse with the substrate (pers. obs.) and survive.

The objectives of this project are to a) stabilize storm-generated *Acropora* species fragments in Biscayne National Park (BNP), and b) develop a suitable reattachment protocol that can be followed by trained experienced volunteers or conservation organizations. Fragment selection will be focused on those with a compromised ability to reattach due to incomplete tissue cover, small size or presence on an unsuitable substrate. The relative survival of stabilized vs. unstabilized fragments, fragments stabilized with different methods, and different sizes of stabilized fragments will be evaluated to determine project success.



REFERENCES

- Fong P, Lirman D (1995) Hurricanes cause population expansion of the branching coral *Acropora palmata* (Scleractinia): Wound healing and growth patterns of asexual recruits. *Mar Ecol* 16(4):317-335
- Lirman D (2000) Fragmentation in the branching coral *Acropora palmata* (Lamarck): growth, survivorship, and reproduction of colonies and fragments. *J of Exp Mar Biol & Ecol.* 251:41-57
- Miller MW, Baums IB, Williams DE, Szmant AM (2002) Status of candidate coral, *Acropora palmata*, and

its snail predator in the upper Florida Keys National Marine Sanctuary: 1998-2001. NOAA Tech Memo NMFS-SEFSC-479, 27pp

Ward-Paige CA, Risk MJ, Sherwood OA (2005) Clionid sponge surveys on the Florida Reef Tract suggest land-based nutrient inputs. Mar Poll Bull (in press, available online: [doi:10.1016/j.marpolbul.2005.04.006](https://doi.org/10.1016/j.marpolbul.2005.04.006))

RELEVANT LINKS

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<http://soundwaves.usgs.gov/2003/07/awards.html>

Biscayne National Park

www.nps.gov/bisc

ACROPORA SPP. STATUS

***Acropora* spp. assessment of population condition and capacity for recovery of the threatened coral species, *Acropora palmata* in Curacao, Netherlands Antilles. (Kramer, Williams, Miller)**

This portion of the *Acropora palmata* diagnostic monitoring has been funded by the Curacao Sea Aquarium and Royal Caribbean Cruise lines. Like our monitoring and assessment projects in other regions, this project aims to:

- 1) Assess and document *A. palmata* abundance and colony condition in three representative regions of coral reef habitat on the southern coast of Curacao.
- 2) Document the prevalence of 'threats' to *A. palmata* survivorship including disease, bleaching, predation, and overgrowth.
- 3) Repeat surveys of selected colonies after one-year to assess the importance of observed 'threats' in driving population mortality.
- 4) Estimate the potential for population recovery through sexual recruitment by estimating juvenile *A. palmata* abundance within permanent study plots after one year.
- 5) Compare colony condition data (the prevalence of each 'threat' and rate of progression) in Curacao with other regions surveyed throughout the Caribbean.

RELEVANT LINKS:

Curacao Sea Aquarium

<http://www.curacao-sea-aquarium.com>

Detailed Monitoring Protocol: [NMFS-SEFSC-543](#)



ACROPORA SPP. STATUS

***Acropora* spp. monitoring in the Eastern Caribbean with [Sea-mester](#) Program (Williams, Miller and Kramer)**

Beginning in 2005, we have formed a partnership with the Sea-mester Program which provides at-sea college level science and seamanship curriculum. The staff biologist leads the students in applying our *Acropora* spp. monitoring protocol at several sites throughout the eastern Caribbean. Taking advantage of Sea-mester's at-sea platform and regular, once per semester itinerary (http://www.seamester.com/pages/route_map.php), current monitoring sites include appropriate populations in the British Virgin Islands, Bequai in the Grenadines, and the Green Island area of Antigua.

This partnership has provided opportunity to 1) evaluate the appropriateness of SEFSC's *Acropora* monitoring protocol developed in the Florida Keys to other sites in the Caribbean, 2) establish partnership with Sea-mester's ongoing at-sea platform which can provide regular access to remote sites in the eastern Caribbean at negligible cost, 3) provide training/capacity building in coral monitoring for staff and students of Sea-mester and allowed them to participate in a 'real world' scientific endeavor which directly informs Endangered Species conservation. Monitoring data and photographs will be entered into an established Access database by Sea-mester staff and students at each of their site surveys and provided to SEFSC for comparison with results from the Florida Keys, Navassa, and Curacao.

RELEVANT LINKS

SeaMester Program

<http://seamester.org/index.php>

Detailed Monitoring Protocol: [NMFS-SEFSC-543](#)

ACROPORA SPP. STATUS

Acropora spp. genetics (Miller et al.)

An important aspect of information required to accurately conserve and manage marine clonal invertebrates relates to population genetic characteristics, specifically connectivity among groups of organisms in different locations throughout the range, and the clonal structure (how many genetic individuals are there in what spatial pattern). These questions were addressed for the threatened elkhorn coral, *Acropora palmata*, in a collaborative project with academic partners at Univ of Miami and Louisiana State Univ by developing highly variable microsatellite markers (Baums et al 2005 that can distinguish genetic individuals of this highly clonal species. Populations from throughout the Caribbean basin were sampled and analyzed. Two genetically distinct populations were found (eastern distinct from western Caribbean locations, with a midpoint around Puerto Rico/Mona Island, Baums et al 2005). Also, there is extreme variation in the genotypic diversity of elkhorn coral populations in different locations. For example, those sampled in the Florida Keys were composed of a single genotype (i.e. all colonies had originated from fragments of a single mother colony) while at Navassa Is (see project description below), every colony was a distinct genotype (i.e. all had recruited from larvae, not fragments). Overall, populations in the eastern Caribbean were more robust, showing higher genotypic diversity, higher colony density, and better colony condition.

Currently, we are using these genetic markers to explore the relationship between a colony's genotype and its ecological performance as determined in the long term genetic monitoring described above. We hypothesize that we may find individual genotypes that have e.g., higher growth rates, less susceptibility to disease or bleaching that could be utilized for restoration and enhancement purposes.

PRODUCTS:

Baums IB, Miller MW, Hellberg ME (2005b) Regionally isolated populations of the imperiled Caribbean coral, *Acropora palmata*. *Molecular Ecology* 14:1377-1390

Baums IB, Miller MW, Hellberg ME (2006) Geographic variation in clonal structure in a reef building Caribbean coral, *Acropora palmata*. *Ecological Monographs* 76:503-519.

RELEVANT LINKS:

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Dr. Michael Hellberg, Louisiana State University

<http://www.biology.lsu.edu/webfac/mhellberg>